



PRESS RELEASE

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The brain stays tuned, even while asleep

Even when sleeping, the brain detects sounds - particularly those signaling danger - and can react to them, say scientists from the UNIGE and the Institut Pasteur.

During sleep, the brain must achieve a delicate balance: disconnecting from sensory input to allow restorative functions, while remaining alert enough to wake if danger arises. How does it sort through external stimuli - particularly sounds - during sleep? Scientists from the University of Geneva (UNIGE) and the Institut Pasteur have studied how the brain responds to so-called “rough” sounds, such as screams or alarms. They discovered that these sounds are systematically processed, unlike other sounds, triggering specific brain waves. These results, published in the journal *Scientific Reports*, provide a better understanding of certain perceptual disorders, such as hyperacusis (hypersensitivity and/or intolerance to certain sounds), as well as the impact of repeated nighttime disturbances on brain function.

Roughness is an acoustic property characterized by rapid modulations of sound intensity, between 40 and 100 times per second. “Unlike speech, where syllables occur at a rate between 4 and 8 Hz, rough sounds hit the auditory system at much higher frequencies, producing a shrill and often unpleasant sensation,” explains Luc Arnal, a researcher at the Institut Pasteur, who co-directed the study. “This quality - typical of audible alarms, human screams, and infant cries - is precisely what makes them so effective: they automatically capture our attention to signal imminent danger.” These sounds directly activate the amygdala, a brain region involved in emotional responses and attention.

Testing different sounds during sleep

While the effect of sound roughness on the brain in the waking state is now well explored, what happens during sleep was still largely ignored. “Our research is essential not only for understanding disorders such as hyperacusis, but also for evaluating the serious impact of nighttime noise on health,” stresses Sophie Schwartz, full professor in the Department of Basic Neurosciences at the UNIGE Faculty of Medicine and co-director of the study.

The researchers recruited 17 volunteers to sleep in specially equipped rooms where their brain activity was monitored using electroencephalogram (EEG). “We then played various types of human cries and ‘false cries’ at low volume, manipulating pitch and roughness to elicit brain responses without waking the participants,” explains Guillaume Legendre, a researcher in Sophie Schwartz’s team and first author of the study. “And it was indeed the roughness - regardless of whether the sound was high- or low-pitched - that activated the brain’s alert systems”.

High resolution pictures

The research team also observed two key phenomena. First, rough sounds consistently triggered a brain response, unlike other types of sounds. Second, sound roughness correlated with an increase in sleep spindles. “These are short bursts of brain activity elicited in response to a sensory, and potentially disturbing, stimulus during sleep,” says Guillaume Legendre.

Intense emotional triggers

“Sound roughness is not commonly encountered in everyday environments. In both humans and animals, it’s typically reserved for urgent, high-stakes communication,” explains Luc Arnal. “However, overexposure to these sound frequencies can evoke very different emotional reactions depending on the individual - sometimes irrational or even aggressive.”

More broadly, this work contributes to a better understanding of the emotional pathways linked to sound, pathways that are involved in psychiatric and neurological conditions such as hyperacusis and tinnitus, as well as epilepsy and Alzheimer’s disease, where auditory processing can be disrupted. “And as we live in increasingly noisy environments, especially in cities, it is vital to understand how sounds affect our brain during sleep - and by extension, our physical and mental health,” concludes Sophie Schwartz.

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